the serving AP of the UD whereas AP_1 and AP_2 are stand-by APs. In this diagram, the stand-by AP **15** has the cluster set manager (CSM) **22** for the user device (UD) **10**. The CSM **22** of the UD knows the identity of the current serving AP **13** of the UD.

[0041] If having a clear line-of-sight (LOS) between the UD **10** and the serving AP **13**, the UD **10** may perform the uplink access via its serving AP **13** and, after a successful uplink access, uplink data transfer may be done via the serving AP **13**. However, in the uplink access scheme described above in a mmWave 5G network, it is possible that, the UD performs a successful uplink access via an AP which is not its serving AP, such as with APs **14** or **15** rather than AP **13** in this example. With features as described herein, the problem of how uplink data transfer can be accomplished in this scenario may be addressed.

[0042] Generally, since the serving AP **13** provides the best link quality, it is the preferred AP for both DL and UL communication for the UD **10**; so that data throughput can be maximized. If the uplink-access AP is not the serving-AP **13**, configuring the uplink data transfer via the serving AP **13** requires communicating the uplink resource request of the UD to the serving AP **13**. For delay-intolerant applications with ultra-low latency constraints on data delivery, the latency of forwarding the UL resource request to the serving AP **13** would result in significant additional delay in the uplink data transfer. With features as described herein, various methods and apparatus may be provided for uplink data transfers which are suitable to meet the performance goals of the various types of applications.

[0043] When the uplink-access AP is not the serving-AP **13**, there are at least three options in which the uplink data transfers could be accomplished. This may be accomplished by at least partially using an uplink-access AP (such as **14** or **15**) which is not the serving-AP. These at least three options are referred to herein as: Serving-AP uplink transfer, Solicited-AP uplink transfer, and Assisted-AP uplink transfer.

[0044] Serving-AP Uplink Transfer:

[0045] In this scheme, the uplink resource request received by the uplink-access AP (**14** or **15**) is forwarded to the serving AP **13**, which in turn allocates uplink resources for the UD **10**. Thus, the uplink data transfer is accomplished via the serving AP **13**. This scheme may be used for applications which require maximized uplink data throughput, but can tolerate the additional latency incurred due to forwarding the uplink request.

[0046] Solicited-AP Uplink Transfer:

[0047] In this scheme, transfer of the uplink data transfer is performed through the uplink-access AP (**14** or **15**). All other communication between the UD and the network (such as downlink data transfer) are done through the serving-AP **13**. This scheme may be used for applications requiring ultra-low latency data transfer with strict delay constrains on data delivery.

[0048] Assisted-AP Uplink Transfer:

[0049] In this scheme, transfer of the uplink data begins through the uplink-access AP (**14** or **15**). However, at the same time, the uplink-access AP makes an estimate how long the uplink data transfer will continue and/or the throughput requirement. This estimation can be based on the data buffer status received from the UD, or other information about the underlying application. This estimation can also be based on observation of the uplink data transfer over a time interval. Based on this estimate, the uplink-access AP (**14** or **15**) may send a request for uplink data transfer handover of the uplink data transfer to the serving-AP **13**. After the serving-AP **13** receives the uplink data transfer handover request, it may initiate scheduling of uplink resource allocation to the UD **10** to transfer the remaining uplink data. This scheme is useful for minimizing the start-up delay in the uplink data transfer, and subsequently maximizing uplink throughput and efficiency of uplink transfer.

[0050] When an UD **10** performs uplink access via a stand-by AP **14** or **15**, a mechanism may be used for downlink communication from the stand-by AP and the UD. In order to enable rapid rerouting protocol, the stand-by APs of an UD, or a subset of it, may have pre-configured downlink control channels which the UD **10** may monitor. Thus, if the UD performs an uplink access with a stand-by AP which has a pre-configured DL control channel for the UD, the AP may use that channel to send responses to the uplink access. However, if the stand-by AP is not pre-configured with a DL control channel for the UD, the UD may indicate in the uplink access request the particular DL control channel of the stand-by AP it will monitor.

[0051] User Device Functions:

[0052] The access points in the cluster set of an UD may be pre-configured with the following information with respect to the UD, or the UD may include the following information in its uplink access request message to a stand-by AP:

[0053] The downlink control channel to be used by the stand-by AP for sending the response to the uplink resource request from the UD.

[0054] The priority information for uplink data transfer for which this uplink resource request is being made.

[0055] After sending the uplink resource request, the UD may monitor the downlink control channel for the stand-by AP as indicated in the uplink access message or preconfigured.

[0056] Access Point Functions:

[0057] On receiving an uplink resource request from the UD, the AP may determine whether it is the serving AP for the requesting UD. If the AP is not the serving AP for the requesting UD, the AP may do the following:

[0058] Send an acknowledgement to the UD indicating successful uplink access.

[0059] Determine the uplink data transfer scheme to be used based on the priority information (which is either pre-configured in the stand-by AP or included in the uplink request message).

[0060] Depending on the data transfer scheme, the AP may perform the procedures for the determined uplink data transfer scheme (such as Serving-AP, or Solicited-AP, or the Assisted-AP for example). Examples for these three options are described below.

[0061] Procedures for Serving-AP Uplink Transfer:

[0062] In this data transfer scheme, the additional functions of the various components of the system can be described as follows.

[0063] User Device Functions:

[0064] The UD may include the following additional information in its uplink access request message to a stand-by AP (or the AP may be pre-configured with these information about the UD):

[0065] Its serving-AP identification, to which the uplink data transfer handover request for uplink data transfer should be delivered.